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ANTERIOR REGENERATION IN A SEXTHECAL SPECIES OF LUMBRICID EARTHWORM

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Records of regeneration, in an anterior direction, at known levels, by posterior pieces of lumbricid earthworms have been brought together in two recent contributions, the first (Gates, 1949) containing all that had been found for *Eisenia foetida* (Savigny) 1826, the second (Gates, 1953) those for the other species that had been studied. Records also have been found of anterior regeneration by a number of specimens, unwittingly used along with *E. foetida*, that must have belonged to yet another species. Identification of this species is the problem with which this note is concerned.

The records involved are available only because it had been found to be "a tedious operation cutting off a definite number of segments". Accordingly, "the number of segments cut off was not counted at the time" . . . but was calculated "after regeneration by the position of the vasa deferentia[1] or segments containing the seminal receptacles" (Morgan, 1895, p. 452). The latter organs, now usually called spermathecae, were said to be normally in segments "9–10–11" (*idem*, p. 455). Such a characterization with reference to paired organs of earthworms certainly can be understood to indicate presence of three pairs of the spermathecae, located one pair each in segments ix, x and xi. But, *E. foetida* has only four spermathecae, usually present, according to various authorities, in ix–x though occasionally in x–xi. The variation does not involve location of spermathecal pores which are on intersegmental furrows 9/10 and 10/11. In view however of the difference in internal location might it be possible that two pairs of spermathecae were so located as to require reference, in most cases, to three segments?

[1] This means: segmental location of the external openings of the deferent ducts, i. e., the male pores. GEG

In this connection location of spermathecae was determined in each older individual (30 clitellate and 4 late juvenile) of the first entire colony of *E. foetida* that was accessible. Some variation as to which of two consecutive coelomic cavities any spermatheca got into as it grew through the parietes was indeed found (Table below). Never-

Table 1

Segmental location of spermathecae in a colony of *E. foetida*

Segments	Number of specimens	
9–10	17	
10	2	
10–11	4	
9, 11	1	
L9, L10, R10	3*	
R9, R10, L10	1	
R10, L10, L11	1	29
L9, L10, R9, L11	1	
L9, L10, R10, R11	1	
R9, R10, L9, L11	1	
R9, R11, L10	1	4
Spiral abnormality in metamerism of the spermathecal region	1	1

* On the left side spermathecae in ix and x, on the right side both spermathecae in x.
Each worm had four spermathecae.

theless, only in four of the thirty-three metamerically normal worms is it necessary to refer to three segments to indicate spermathecal location, and in two cases all spermathecae are actually in one segment. These results, together with previous findings, show it is unlikely that twenty-two out of twenty-seven specimens of *E. foetida* would have had spermathecae in three segments. Furthermore, the method by which location of spermathecae of the other five specimens was indicated, e. g., "–7–8", as if the first of three pairs[2] had not been found, also supports the interpretation of "normal" that was first suggested above, i. e., presence of three pairs in three consecutive segments[3].

[2] In one case, "–6–7?", in which the question mark seems to indicate uncertainty but as to what, was not explained.

[3] Seminal receptacles cannot be regarded as a *lapsus calami* for seminal vesicles. The latter are four pairs, in ix–xii, in *E. foetida*. Other species may have only three pairs but they are not in three consecutive segments, ix, xi–xii.

Accordingly, it is concluded that Morgan's specimens with spermathecae in two segments were quadrithecal and, as he supposed, *E. foetida*, but that the others were of some sexthecal form with spermathecae in ix, x, xi. Three lumbricid species of this country are so characterized: *Allolobophora chlorotica* (Savigny) 1826 and *Eisenia lönnbergi* (Michaelsen) 1894 with spermathecal pores on 8/9–10/11, *Dendrobaena octaedra* (Savigny) 1826 with the pores on 9/10–11/12. *E. lönnbergi*, though at present within the same genus as *foetida*, has a quite different habitus, is a native of the southern states, has never been reported from the vicinity of the region where the worms in question apparently were secured, has not been found in manure heaps — the source of the material — and is unlikely to have been involved. *A. chlorotica* normally has an obvious yellow or green coloration, as well as other characteristics that would immediately distinguish it at a glance from *foetida*, and has only once been reported from the vicinity of a manure pile. *D. octaedra* does have the same red pigmentation that characterizes *E. foetida*, uniformly distributed (instead of in transverse bands) as in many individuals of *E. foetida*, has been found occasionally in manure piles, and does have much less special glandularity in the region around the male pores (so that site of the male pores would be less easily recognizable). Of the three species, *D. octaedra* is the one most likely to have been inadvertently accepted as *E. foetida*. Nothing, however, has been known of regeneration at levels in front of 15/16 in any species of *Dendrobaena* and *D. octaedra* has not, apparently, been available to others who have studied regeneration in earthworms. An unusually large *octaedra* proportion of the population (in the manure heap that provided the experimental material under consideration) seemingly is indicated by such figures as are available: one of eleven specimens (Table 3, Morgan, 1895), five of sixteen (Table 10), six of eleven (Table 12, first half), four of nine (Table 13), twenty-two of the twenty-seven cases in which spermathecae were mentioned.

The number of records (22) of anterior regeneration that can now be recognized as of *octaedra* is larger than for any other lumbricid (Gates, 1953) except *E. foetida* and two species which have not yet been studied in this country, *Allolobophora terrestris* (Savigny) 1826 and *Lumbricus rubellus* Hoffmeister 1843. These records (Table below) show that head regeneration is possible at each level from 1/2 to 8/9 inclusive. The five segment regenerate shows that equimeric regeneration can be expected at each level from 1/2 to 5/6 inclusive at least.

Failure to secure equimery at levels behind 3/4 indicates that conditions, either of the external or internal environment or both, were less than optimal for regeneration by *octaedra*, as well as for *E. foetida*[4]. The results obtained from four worms that were deliberately cut diagonally instead of transversely (note under table) may indicate that head regeneration is also possible at levels back at least to 12/13.

Table 2

Number of segments in head regenerates of Morgan's sexthecal earthworms

Level of amputation*	Number of segments regenerated				Record quoted from Morgan, 1895, pages
	2	3	4	5	
EL 2/3	1	–	–	–	447
EL 3/4	3	1	–	–	447, 455
EL 4/5	–	2	–	–	448, 456
EL 5/6	–	1	1	–	455
EL 6/7	1	1	1	–	455, 456
EL 7/8	–	1	1	–	456
EL 8/9	1	1	1	1	455, 456

* A symmetrical homoeotic would not have been recognizable after operation.

EL Estimated level. Estimation made, after regeneration and presumably after preservation, from position of male pores and/or location of spermathecae.

When cuts were made diagonally "anterior segments obliquely amputated" (p. 457), four to twelve segments were said to have been completed. In three of these, which had spermathecae after regeneration in "9-10-11" and in which 4, 8, and 12 segments had been "completed", presumably no segments were completely excised. The other specimen had a hypomeric regenerate presumably (indicated by location of the spermathecae in "8-9-10"). All of i–iii was then removed in addition to parts of iv–x ("7 segments completed").

After excision of a piece estimated to comprise 10½ segments, and subsequent regeneration (p. 455), there were still spermathecae in the first two segments of the substrate. The estimate could have been correct, regardless of species, only if the worm involved had been homoeotic (+ 1 or more), or if spermathecae had been developed in the substrate during regeneration. Nothing of the latter sort has ever been recorded from the Lumbricidae.

[4] The number of segments in the head regenerates of *E. foetida* was smaller than has been obtained (Gates, 1949) and in view of this evidence from two different species the less favorable conditions may have been in the external environment.

SUMMARY

Individuals of some sexthecal species were frequently used along with *E. foetida* in Morgan's early studies of earthworm regeneration. From the information available as to distribution, habitat, habitus, etc., of the sexthecal species of this country, it is concluded that only *D. octaedra* is likely to have been inadvertently taken for *E. foetida*. Nothing has been known of anterior regeneration in the genus *Dendrobaena* and the records now attributable to *D. octaedra* show that it is able to develop a head regenerate, in an anterior direction, at each level back to 8/9, possibly to 12/13, and, in better conditions, complete replacement of excised segments may be expected at least at all levels from 5/6 anteriorly.

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